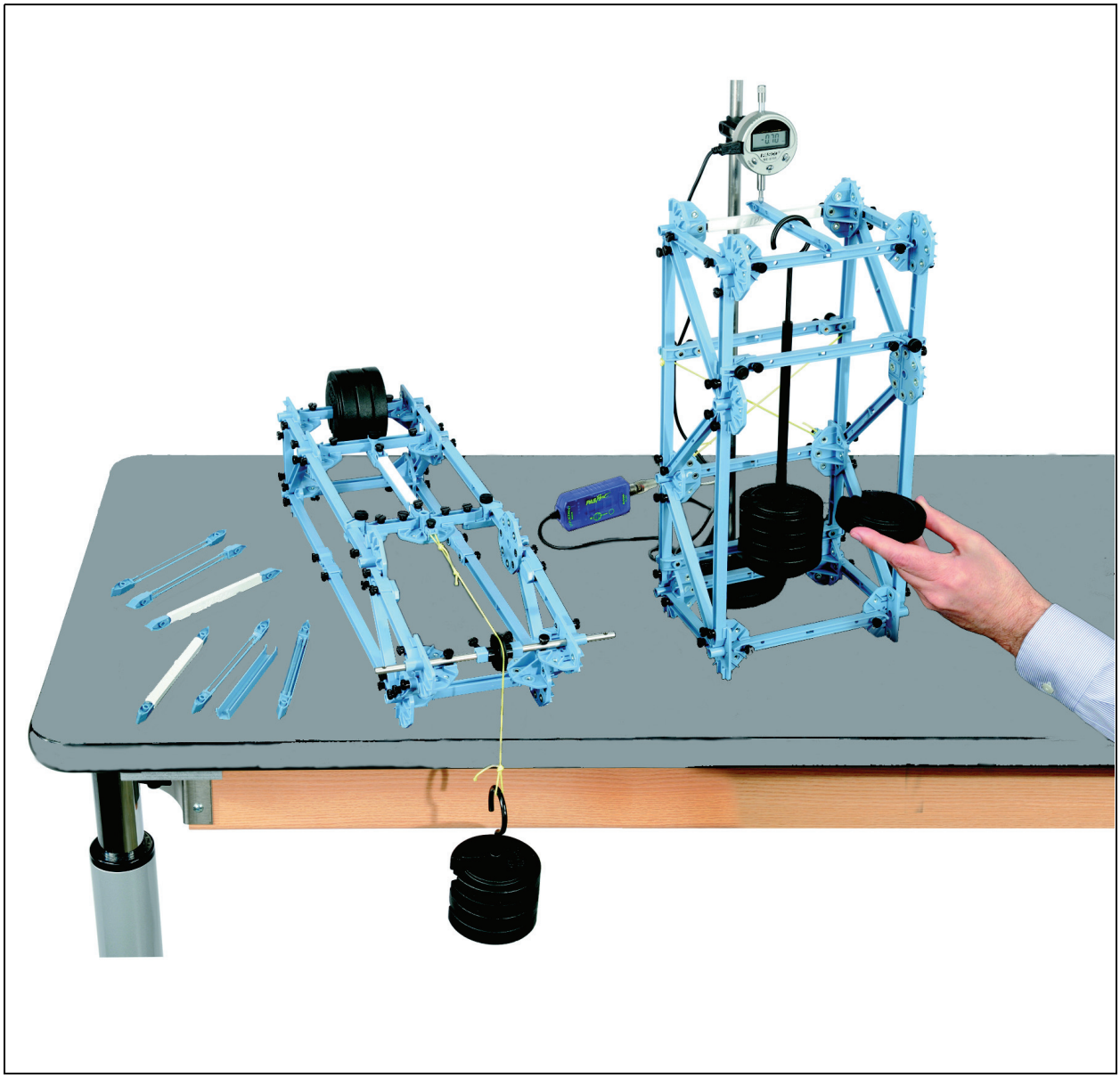
PASCO®

Instruction Manual
012-12111A

PASCO Structures System

Cast Beam Structures Set

ME-7009



The cover page shows the ME-7009 Cast Beam Structures Set models of a Tension Fixture (left) and a Test Fixture (right). The tension fixture uses a hanging mass to pre-stress a cast beam member, and the test fixture can be used after the cast beam member has dried and the mold has been removed. A hanging mass applies a load to the cast beam, and a displacement sensor measures the amount of deflection.

The Tension Fixture and Test Fixture can be constructed concurrently with the items in this set.

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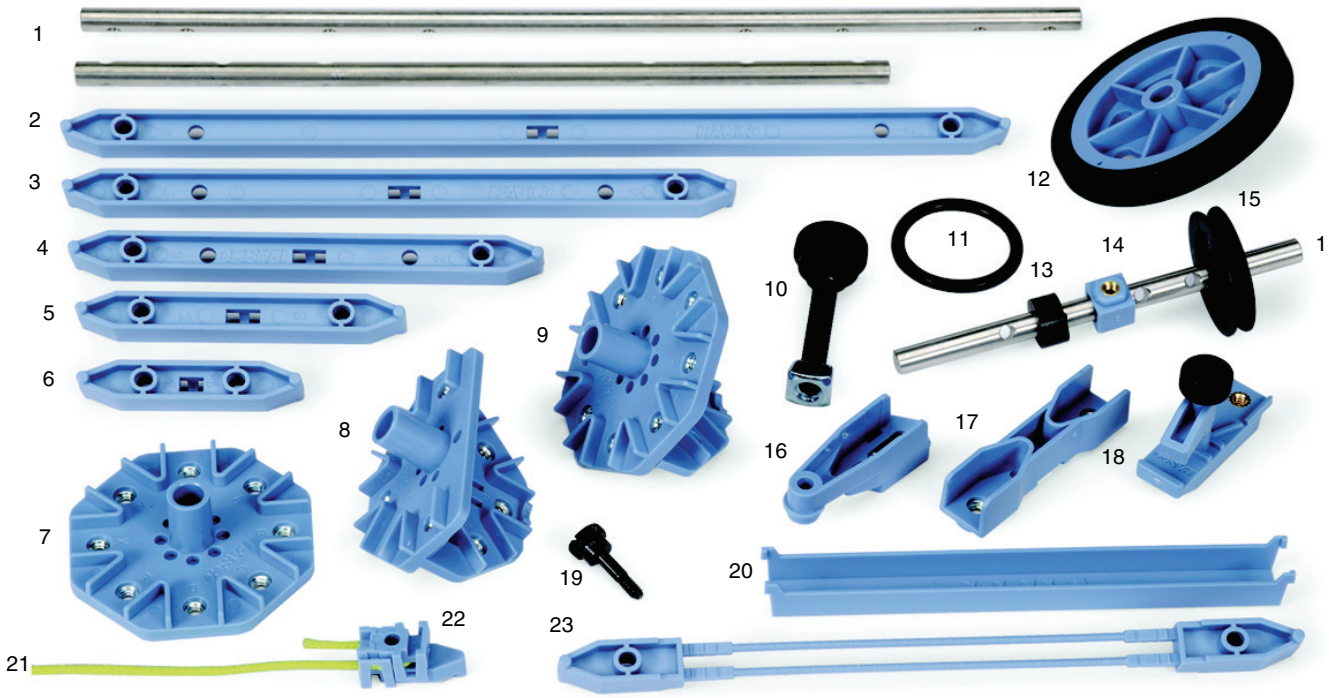


Included Items	Qty	Included Items	Qty
1. Axle (2 each of 3 lengths)	6	13. Spacer	12
2. #5 Beam (24 cm long)	8	14. Collet	24
3. #4 Beam (17 cm long)	18	15. Pulley	12
4. #3 Beam (11.5 cm long)	18	16. Angle Connector	24
5. #2 Beam (8 cm long)	8	17. Straight Connector	24
6. #1 Beam (5.5 cm long)	8	18. Sliding Connector	12
7. Flat Round Connector	6	19. Screw (6-32)	150
8. Half Round Connector	14	20. Mold (reusable)	10
9. Full Round Connector	6	21. Yellow Cord	1 roll
10. PAStrack Connector	6	22. Cord Tensioning Clip	32
11. “O” Ring	12	23. Rebar Member (17 cm)	30
12. Drive Wheel and Tire	4		

The ME-7009 Cast Beam Structures Set consists of items from the following parts of the PASCO Structures System.

ME-6983 Cast Beam Spares	ME-6997 Full Round Connectors
ME-6993 Truss Set Members	ME-6998A Axle Spares
ME-6994 Truss Set Screws	ME-6999A Angle Connectors
ME-6996 Cord Lock Spares	

Required Materials

In addition to the items included with the Cast Beam Structures Set, the following materials are required:

- Sand,
- Plaster of Paris,
- Spoon, bowl or cup, and water.

Other Equipment

Other PASCO equipment is closely related to the Cast Beam Structures Set or recommended for use with the Set..

Related Equipment*	**Related Equipment***
PS-2199 Load Cell and Amplifier Set	ME-6986 Structures Rod Clamps
PS-2200 100-N Load Cell	ME-6990 Truss Set
PS-2205 Displacement Sensor	ME-6991 Bridge Set
PS-2206 Dual Load Cell Amplifier	ME-6992A Advanced Structures Set
Recommended Equipment*	**Recommended Equipment***
Hooked Mass Set (SE-8759)	Large Slotted Mass Sets (ME-7566 or ME-7589)
Mass and Hanger Set (ME-8979)	Braided Physics String (SE-8050)
PASPORT Interface	Data Acquisition Software

See the PASCO catalog or the web site at www.pasco.com for more information

Introduction

The Cast Beam Structures Set set consists of the Cast Beam Spares Set (ME-6983) and other items from the PASCO Structures System. The Cast Beam Spares Set consists of a beam that is a model of the reinforcement bars (“rebar”) used in construction, and a mold that is used to produce a model of a beam of reinforced “concrete” or prestressed “concrete”. A mixture of fine sand, plaster, and water is poured into the assembled rebar beam and mold. The assembled beam and mold are then put under tension. After the mixture hardens and the mold is removed, the beam can be used as a #4 beam in any PASCO Structure Set.

The other items in the Cast Beam Structures Set can be used to build tension fixtures and test fixtures for the cast beams. Sensors and weights can be used to measure the strength of the cast beam when it is attached to a test fixture or is a component of a PASCO Structure.

About Concrete

Concrete is the most widely used construction material in the world. Non-reinforced concrete is strong in compression but weak in tension. Any appreciable tension (for example, due to bending) will cause the concrete to crack and separate. Non-reinforced concrete must be well supported to prevent bending.

Reinforced Concrete

Reinforced concrete has reinforcement bars (“rebar”), grids, plates or fibers incorporated to increase the tensile strength of the concrete. Since steel is a material that has high strength in tension, it is commonly placed in concrete to add strength and to help the concrete resist tension. Reinforced concrete is sometimes described as *precast* concrete.

Typical reinforced concrete uses reinforcing bars that are round in cross-section and corrugated to improve the bond between the concrete and the steel. The coefficient of thermal expansion for concrete is similar to that of steel, so the concrete conforms to the surface details of the steel, and the concrete’s alkaline chemical environment produces a film on the surface of the steel that makes it more corrosion-resistant.

Prestressed Concrete

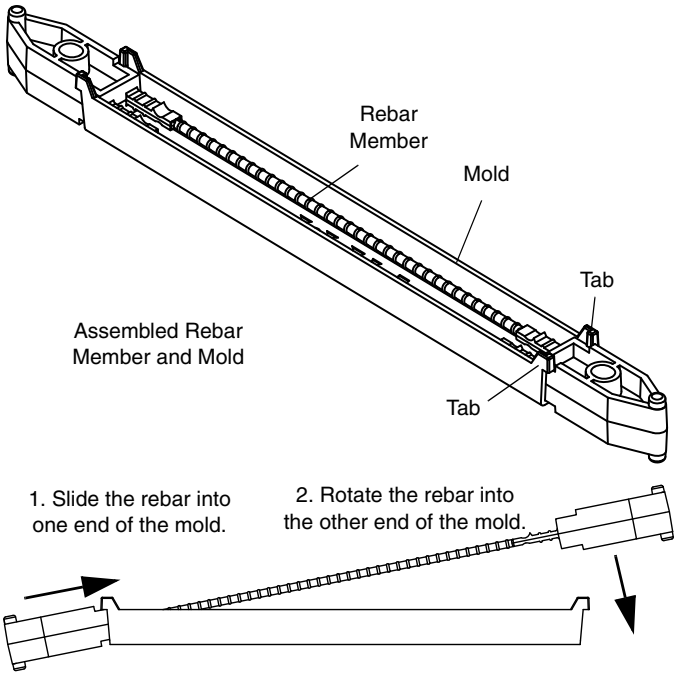
Prestressed concrete is an important method for overcoming the concrete’s natural weakness in tension. The method can be used to produce beams, floors, or bridges with a longer span than is practical with reinforced concrete. One type of prestressed concrete is *pre-tensioned* or *pre-loaded* concrete.

Pre-tensioned concrete is cast around already tensioned tendons (generally of high tensile steel cable or rod). The bond between the tendon and the concrete protects the tendon and allows for direct transfer of tension. However, pre-tensioned concrete requires stout anchoring points for the tendons so the tendons are usually in a straight line. Most pre-tensioned concrete elements are prefabricated and then transported, which limits their size.

Making a Pre-tensioned Cast Beam

Assemble the Mold

- Assemble the rebar member and the mold. One way to do this is to hold the mold in one hand and the rebar member in the other.
- First, slide one end of the rebar into one end of the mold until the tabs of the mold make contact with the notches on the rebar member.
- Then rotate the rebar member down into the mold so that the tabs on the mold click into place on the rebar member.

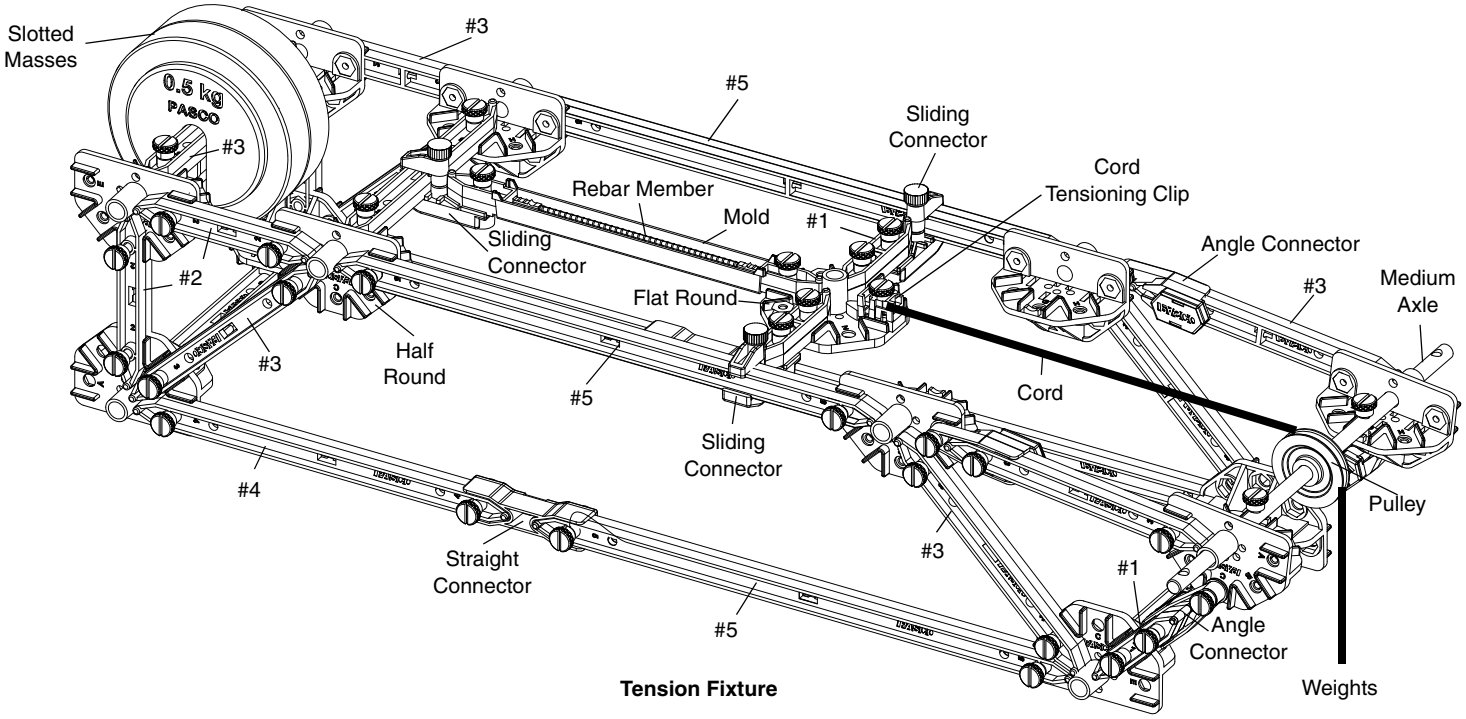

Rebar Member
Mold
Tab
Assembled Rebar Member and Mold
Tab
1. Slide the rebar into one end of the mold.
2. Rotate the rebar into the other end of the mold.

Assemble a Tension Fixture

One way to stretch the rebar member is to build a tension fixture with Structure Set members (see the next page), attach one end of the rebar member to the tension fixture, and then pull the other end of the rebar member (for example, with weights hanging on the end of a cord suspended over a pulley). You can use the ME-7009 Cast Beam Structures Set or the ME-6992A Advanced Structures Set.

Caution: Do not stretch the rebar member with more than 100 N of force (the hanging weight of about 10 kg of mass).

Example Tension Fixture



Tension Fixture

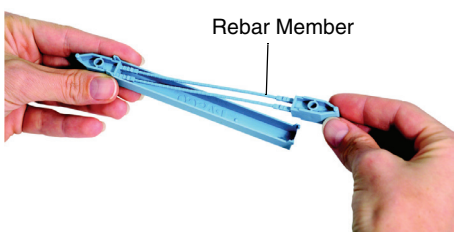
- Make sure that the two Sliding Connectors on the #5 beams are slightly loose so that they can slide freely along the beams.
- Fasten the cord to the Cord Tensioning Clip first and then attach the Clip to the Flat Round Connector.
- Mount the assembled mold and rebar member on the tension fixture. Put slotted masses on the #3 beam at the end of the tension fixture as a counterbalance. Attach weights up to 100 N (about 10 kilograms) to the end of the cord in order to stress the rebar member.

Mix the Concrete

- Mix equal quantities of fine sand and plaster of Paris. [NOTE: This mixture will make a fairly weak cast beam. Decrease the proportion of sand to *increase* the strength of the cast beam.]
- Add a small amount of water to the mixture and stir the ingredients together.
- Continue to add water and stir until the mixture has the consistency of honey.

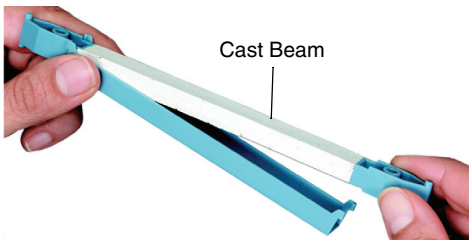
Add the Mixture to the Mold

- Carefully pour the mixture into the assembled mold. You can use a spoon to ladle the mixture into the mold.
- Frequently tap the sides of the mold to help the mixture settle and to remove bubbles. Use the spoon to push the mixture down into the spaces around the rebar member.
- Use a tool such as a table knife or small, flat piece of wood to smooth the top surface of the mixture.



Assemble the Mold

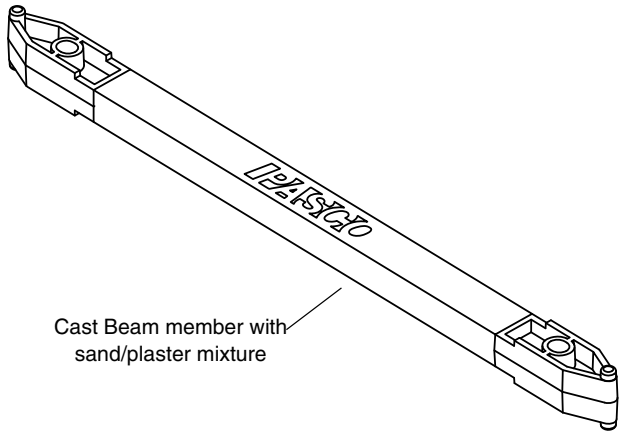
Pour the Plaster



Remove the Mold

After Drying, Remove the Mold

- Let the mixture dry in the mold for 24 hours.
- After the concrete dries, relieve the tension on the beam and then remove the cast beam member from the tension fixture.
- Carefully remove the mold from the cast beam. (The mold can be cleaned and used again.)



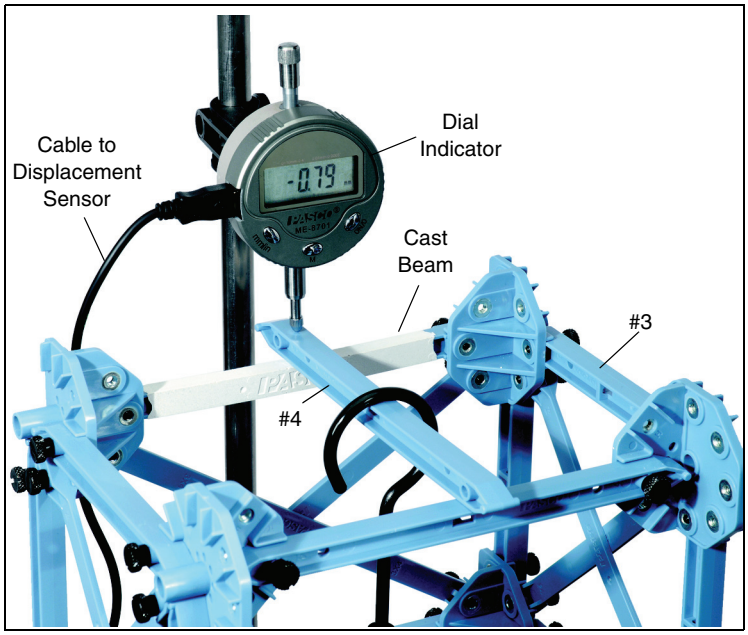
Assemble a Test Fixture

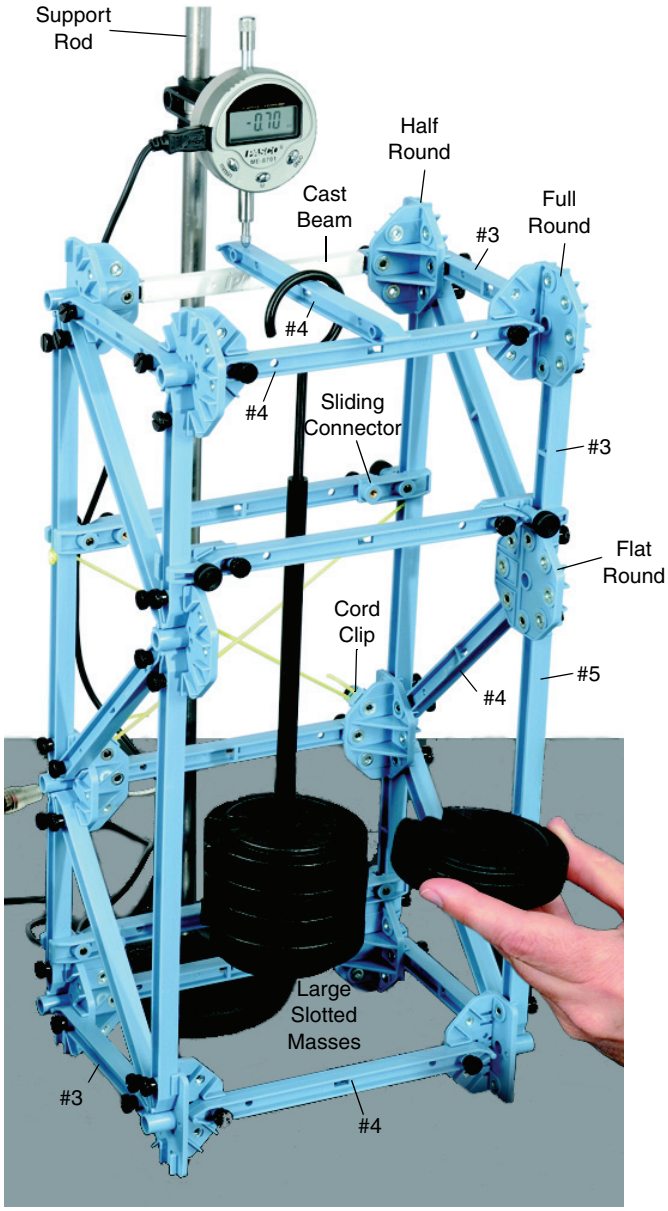
A successful test fixture provides three things:

- Support for the cast beam member.
- Ways to apply a load to the cast beam member.
- Ways to measure the effect of the load on the cast beam member.

Single Point Test Fixture

The example test fixture shown here provides a way for a load of several kilograms to be applied to the middle of the cast beam member while the dial indicator of the PS-2204 Displacement Sensor measures the beam's deflection. The image below shows the details of how the dial indicator is used

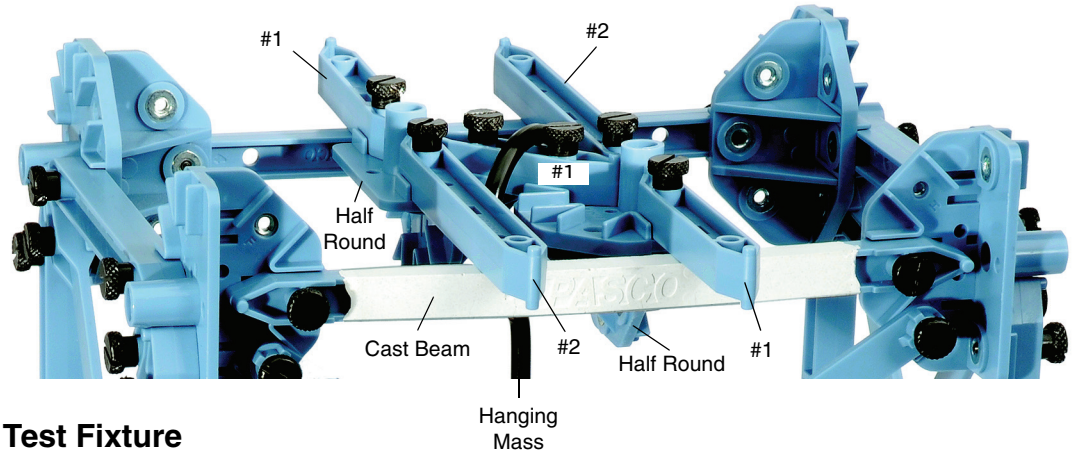




Other Examples of Test Fixtures

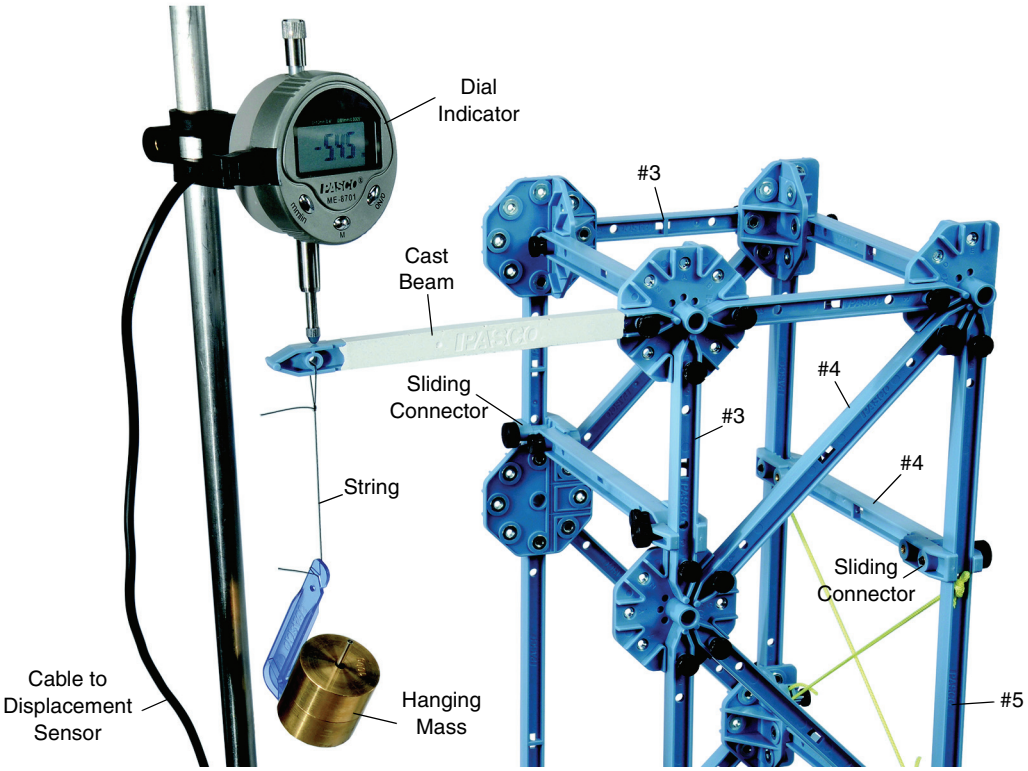
Two Point Test Fixture

The image shows the details of the top of a variation of the previous test fixture. The load on the Cast Beam is applied by two I-beam Members. A dial indicator can be placed on the middle of the Cast Beam to measure its deflection as the load changes.



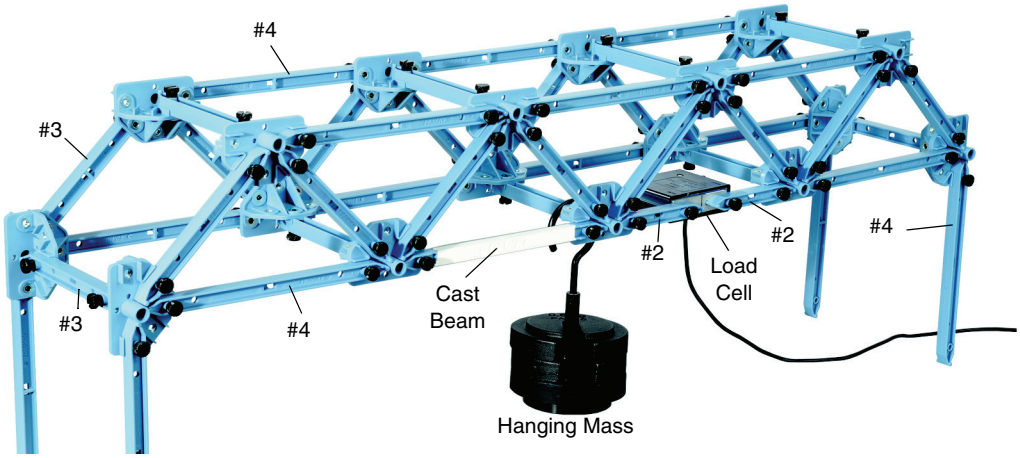
Cantilever Test Fixture

The image shows the Cast Beam in a cantilever position attached to the Full Round Connector at one corner of the top of the text fixture. The load on the Cast Beam is applied by a hanging mass (ME-8979 Mass and Hanger Set) attached to a string (SE-8050 Braided Physics String). The dial indicator is placed on the end of the Cast Beam to measure its deflection as the load changes.

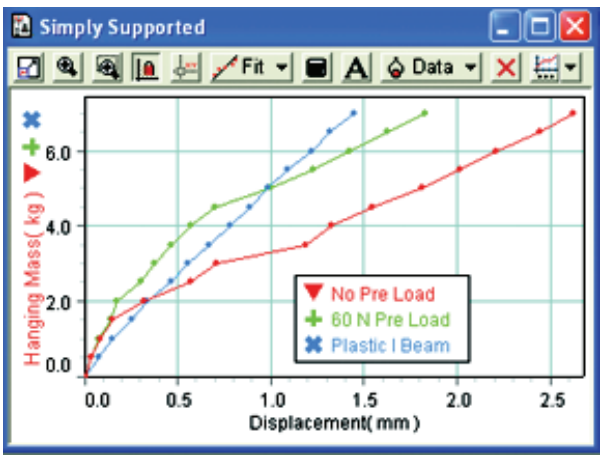


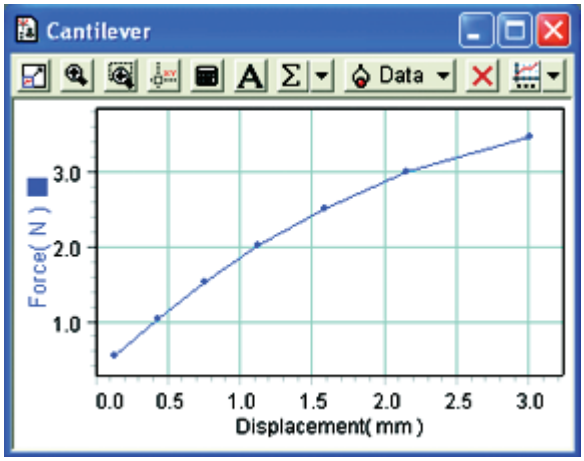
Bridge Test Fixture

The image shows a bridge structure with a Cast Beam member. The load is applied by a hanging mass suspended from a cross member, and the tension through the Cast Beam is measured with a 100 N Load Cell (PS-2201).



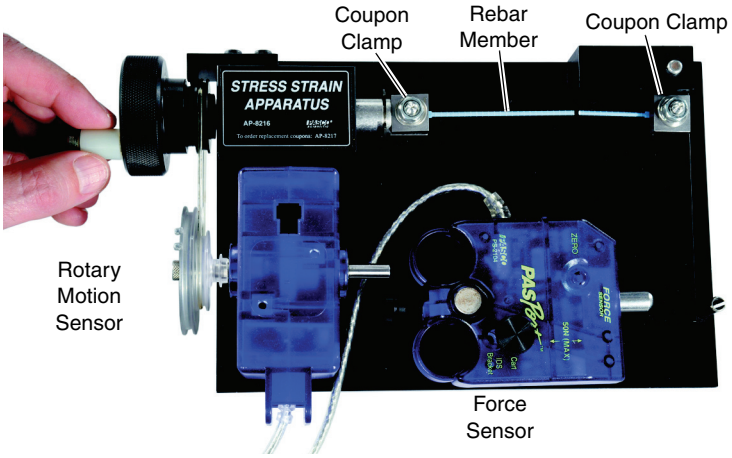
Typical Test Results

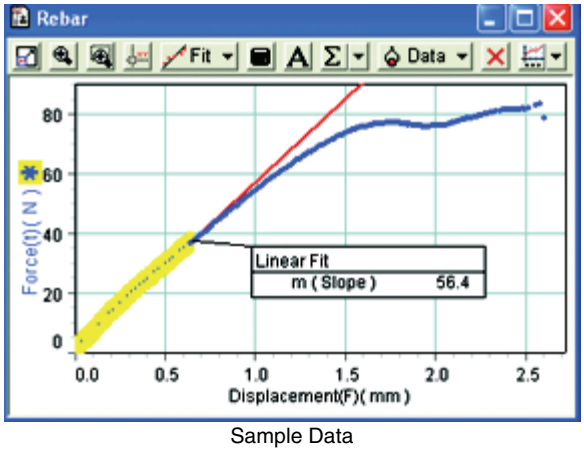




Stress/Strain Test Fixture

The PASCO Stress/Strain Apparatus (AP-8213) can be used to test the strength of the Rebar Member by itself. Use diagonal pliers or strong clippers to cut the ends off the two pieces of “rebar” in the Rebar Member. Mount a single piece of “rebar” into the two Coupon Clamps on the Stress/Strain Apparatus. Turn the crank clockwise to apply tension to the “rebar” until it fails (breaks)..



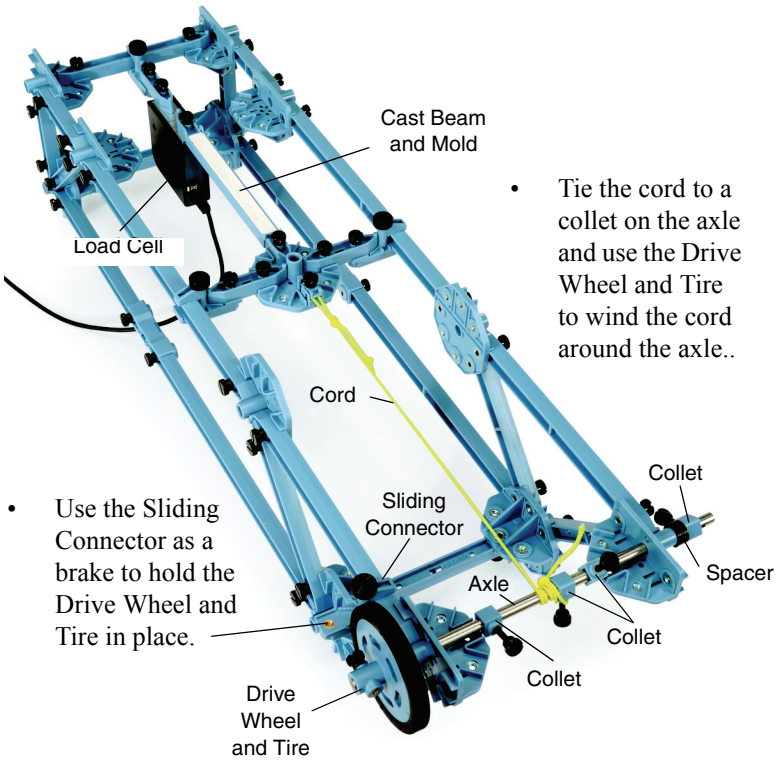


Sample Data

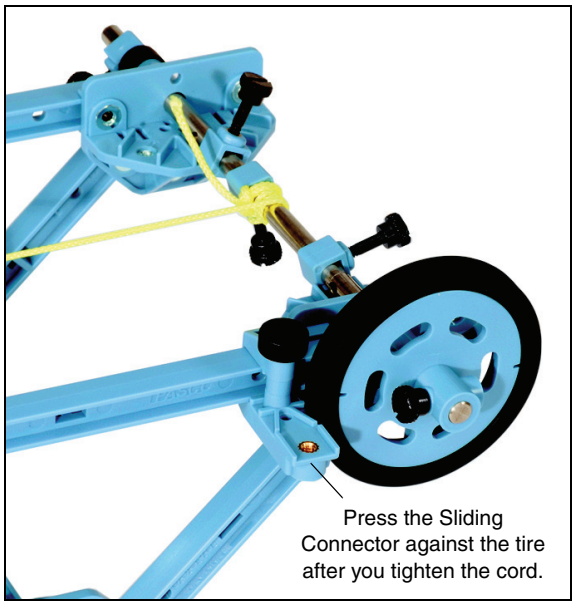
Other Tension Fixtures

Wheel and Axle

Another way to apply a pre-tensioning load to a Cast Beam member as it dries is to use a Drive Wheel and Axle rather than a hanging mass over a pulley. In the image below, the load is measured with a 100 N Load Cell (PS-2201) and the load limit is 100 N.

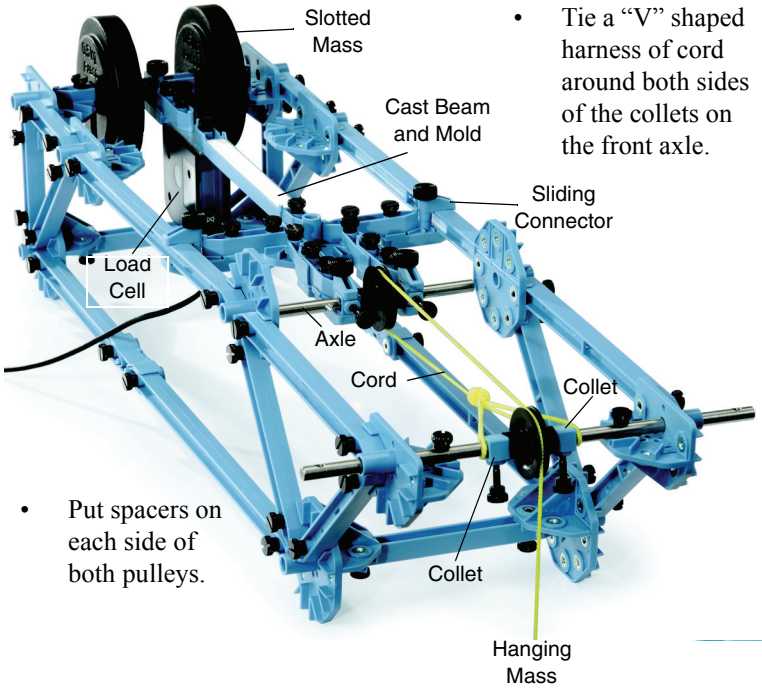


- Tie the cord to a collet on the axle and use the Drive Wheel and Tire to wind the cord around the axle..
- Use the Sliding Connector as a brake to hold the Drive Wheel and Tire in place.

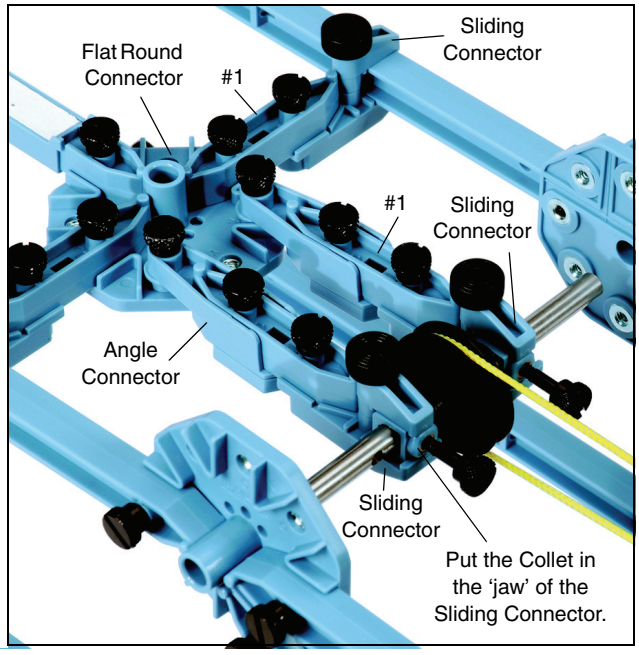


Double Pulley and Axle

Use a hanging mass and two pulleys. The second pulley multiplies the load applied to the Cast Beam member as it dries. In the image below, the load is measured by a 100 N Load Cell and the load limit is 100 N.

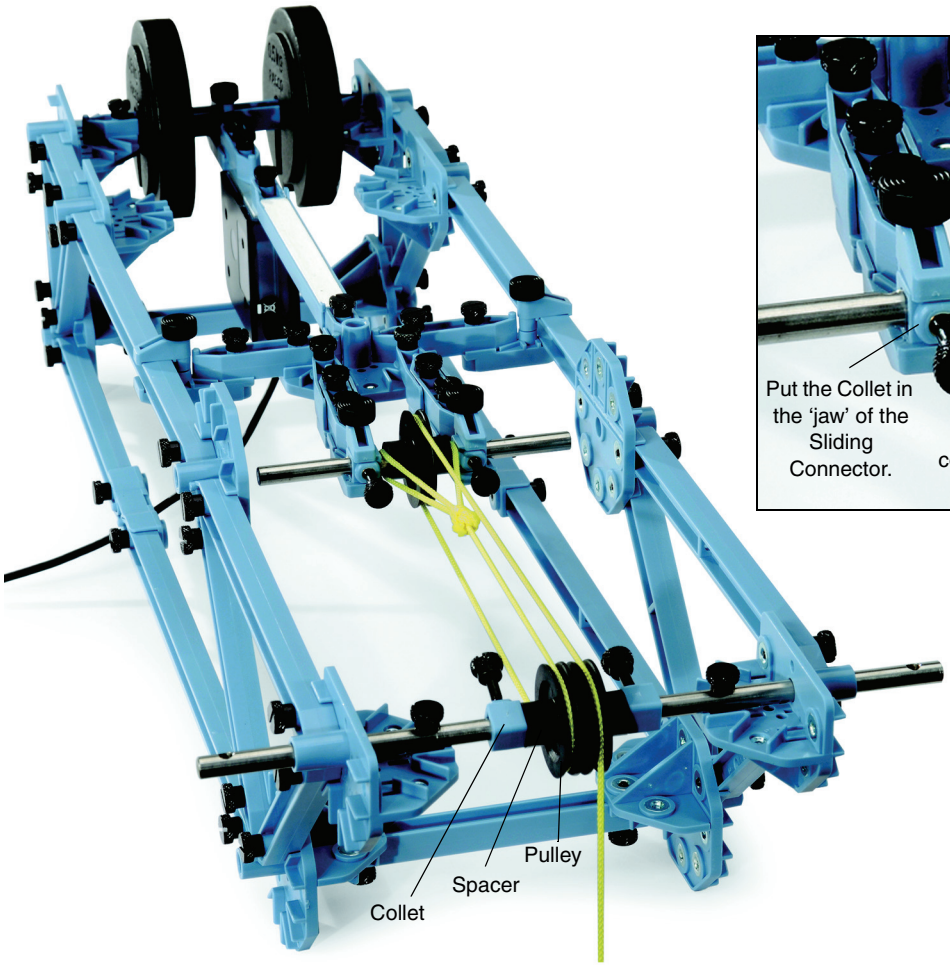


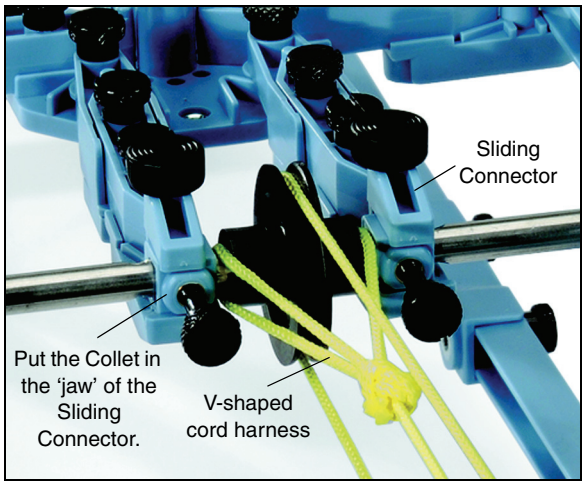
- Tie a “V” shaped harness of cord around both sides of the collets on the front axle.
- Put spacers on each side of both pulleys.



Triple Pulley and Axle

Use a hanging mass and three pulleys. The three pulleys multiply the applied load on the drying Cast Beam more than a single pulley or a double pulley can. The 'block-and-tackle' arrangement of three pulleys has an Ideal Mechanical Advantage (IMA) of 3-to-1. The applied load is measured by a 100 N Load Cell and the load limit is 100 N.





Detail of the V-shaped Cord Harness

Technical Support

For assistance with any PASCO product, contact PASCO at:

Address:	PASCO scientific 10101 Foothills Blvd. Roseville, CA 95747-7100
Phone:	916-786-3800 (worldwide) 800-772-8700 (U.S.)
Fax:	(916) 786-7565
Web:	www.pasco.com
Email:	support@pasco.com

For the latest revision of this Instruction Manual, visit:

www.pasco.com/go?ME-7009

Limited Warranty For a description of the product warranty, see the PASCO catalog. **Copyright** The PASCO scientific 012-12111A *Cast Beam Structures Set Instruction Manual* is copyrighted with all rights reserved. Permission is granted to non-profit educational institutions for reproduction of any part of this manual, providing the reproductions are used only in their laboratories and classrooms, and are not sold for profit. Reproduction under any other circumstances, without the written consent of PASCO scientific, is prohibited. **Trademarks** PASCO and PASCO scientific are trademarks or registered trademarks of PASCO scientific, in the United States and/or in other countries. All other brands, products, or service names are or may be trademarks or service marks of, and are used to identify, products or services of, their respective owners. For more information visit www.pasco.com/legal.

Patents Pending The following PASCO products have patents pending:

ME-6987 Flat Structures Members	PS-2198 Load Cell Amplifier
ME-6990 Truss Set	PS-2199 Load Cell and Amplifier Set
ME-6991 Bridge Set	PS-2200 100 N Load Cell
ME-6992A Adv. Structures Set	PS-2201 5 N Load Cell
ME-6995 Road Bed Spares	PS-2205 Dual Load Cell Amplifier